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temperature being favorable — that some multiply in twenty minutes, others in thirty minutes, and others in forty minutes.

Staphylococcus aureus, which in its growth produces a peculiar golden-colored filament, grows with great rapidity when sown in a medium like faintly alkaline broth at a temperature of 37° C. Into a sterile broth tube a definite number of organisms are put, say eight cocci per cubic centimetre. If placed in an incubator for twenty-four hours at 37° C., and then counted, it is found that 1 cubic centimetre contains 640,000; that is to say, one organism has multiplied eighty thousand-fold in the first twenty-four hours. It would not be expected that the same rate would obtain in the second twenty-four hours, because the material had been used up. After forty-eight hours' growth the counting yielded 248,000,000 per cubic centimetre; that is, only four hundred-fold. In seventy-two hours it was found that there were 1,184,000,000 per cubic centimetre; that is to say, during the last day each had multiplied only five-fold. As the material is used up the rate of multiplication decreases.

Another instance of the rapidity of growth was given. A rabbit was inoculated subcutaneously with 20,000 bacilli of fowl cholera, and died in twenty-four hours. It was found that 15,150,000 microbes were contained in one cubic centimetre of the blood of the animal. The whole of the blood contained twelve hundred millions, showing that each bacillus in twenty-four hours had multiplied sixty thousand times. Those organisms which have their habitat in ordinary temperatures grow very rapidly. Professor Ferdinand Cohn was the first to study the rate of multiplication on the hay bacillus. He calculated that in two days the number of these would be so great that the whole Atlantic Ocean would be densely peopled by them if there was sufficient nutriment, which, fortunately, there is not, and therefore many of them had to go to the wall.

By the motility of bacteria is understood active locomotion. They spin round, they dart to and fro, and pass rapidly over the field of the microscope, and that is on account of their possessing one, two, three, or even a multitude of fine hairs. The organism of typhoid fever possesses several of these *flagellæ*. It has been shown that for retaining this motility a plentiful supply of oxygen is required. If, in a chamber, at one end oxygen is supplied, and at the other nitrogen or hydrogen gas, the organisms will all move towards the end where the oxygen is. If the oxygen is replaced by nitrogen or hydrogen the movement gradually ceases. If water is covered with a scum, it is most probably a motile bacillus which grows in the fluid, and is driven to the surface, where it can derive the best supply of oxygen. In many cases the motility of the organisms is interfered with by their own chemical products.

Within certain of these organisms, but not in all, are formed peculiar corpuscles, which bear the same relation to the organisms as the seed does to the plant. This spore formation is almost entirely limited to the order of bacilli, and in this group there are very many species which do not possess this power. In a number of different species of bacilli, some of which are capable of forming spores and others not; those which have this power may look on very quietly, while those that do not will exhaust all the nutritive material present, growth and multiplication will then cease, and they will gradually die away. Those which form spores have a much better chance of bringing forth new generations than the others.

When organisms do not find suitable materials for their growth, certain changes are brought about called "involution changes." When the bacillus ceases to possess that high degree of vitality that the normal typical bacillus possesses, it gradually undergoes changes which lead to its death. Illustrations were given of what had been described as involution changes, but which were not so. For instance, tubercle bacilli grown under not very favorable conditions may be swollen, and others may appear branched. Some observers took these changes to indicate the death of the organism, but the lecturer was not quite sure that such were "involution changes."

In all these considerations, particularly in reference to the formation of spores, there were a number of facts of very considerable practical importance. The germination of those organisms

which form spores takes place on the same principles as the germination of the spores in the higher fungi. The envelope is broken, the protoplasm contained within it shoots out in the shape of a rod, which when it is fully formed elongates, divides, and multiplies, as in the case of the parent. In this way one bacillus, by repeated multiplication, forms a new crop. When these have reached a certain phase of development they again form spores, which go to start a new generation. These spores have a much greater power of resistance than is possessed by the non-spore-bearing organisms, and can withstand high temperature, dryness, and the influence of light, so much so that it has become almost a recognized method of determining whether a particular species of bacilli forms spores, by subjecting the suspected organism to a temperature of 95° C. or 100° C. If they survive this exposure, and if they survive drying, it may be taken as established that the growth is spore-forming.

HEALTH MATTERS.

The Transmissibility of Hydrophobia from Man to Man.

THE fact that no instance is on record of hydrophobia having been transmitted from man to man has given rise to a doubt as to whether the saliva of human beings suffering from the disease possesses the same virulent properties as that of the dog similarly affected. In not more than five or six of the ten thousand patients treated at the Pasteur Institute was the lesion due to bites inflicted by human beings, and it is evident that statistics bearing on so small a number of cases are of no value one way or the other. It has, however, been proved experimentally, says the *Medical Press*, that the saliva of human beings having succumbed to hydrophobia produces the disease in animals by inoculation, though the incubation period is somewhat prolonged. It may, therefore, be taken as proved that the disease may be transmitted in this way from man to man. It is hardly possible as yet to affirm categorically the possibility of curing hydrophobia after the characteristic symptoms have made their appearance, but recent observations throw a doubt on the incurability of the disease even under these circumstances.

LETTERS TO THE EDITOR.

**** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

On request, twenty copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

The Glacial Grooves on Kelley's Island to be Preserved.

THE world of science will rejoice that at last the most remarkable of the glacial grooves on Kelley's Island is to be preserved as an object-lesson to future generations forever.

Many of the citizens of Cleveland will remember that when, in 1888, the American Association for the Advancement of Science met in their city, an excursion was made to Put-in-Bay on the steamer "City of Cleveland," and that, on the way, the boat stopped at the dock of the Kelley's Island Lime and Transport Company, on the north-east corner of the island, to give the men of science an opportunity to see what there was left of the wonderful glacial grooves that have made that locality famous the world over. A few minutes after the palatial steamer touched the dock at the lime-kilns, the hundreds of expectant excursionists might have been seen swarming around and over the great natural wonder they had come to see, and inspecting it from every point of view. They had come, they had seen, and they were conquered. The expressions of astonishment and delight from the eminent scientific men in the company (among whom were numbered Professors Alexander and N. H. Winchell, Professor Cook of New Jersey, Professor Morse of Boston, Major Powell of Washington, Professor Spencer of Canada), as well as from the great number of intelligent amateurs and others present, were of the most extravagant character; and ardent desire was expressed on every hand that measures might be taken for the preservation of the renowned glacial phenomenon, concerning which all felt that the half had

not been told them. But, alas, the interests of a great business corporation seemed to demand the destruction of the last remnant of these most celebrated works of the glacial age. Many were the regrets expressed at the near prospect of the accomplishment of this real calamity to the interests of scientific education.

But so it was not to be. Mr. M. C. Younglove, the president of the company, then gave his word that the groove which had excited their admiration should be preserved. For three years the workmen have sacredly spared the spot. Gunpowder and dynamite have been kept from injuring these most wonderful exhibitions of nature's most wonderful geologic work, until we are permitted to record that to-day it has been placed beyond danger. At Mr. Younglove's invitation, Rev. Dr. Sprecher and myself have carefully surveyed the premises with him, and, on presentation of the case to the company at its annual meeting on the island to-day, the following resolution was unanimously passed:—

“Resolved, that, in the name of this corporation, the secretary and treasurer be and are hereby authorized to deed to Mr. M. C. Younglove a piece of the groove at the south-east corner of the north quarry at Kelley's Island, said deed to convey a strip of land fifty feet wide and one hundred feet long; said strip of land to be deeded by him to some scientific or historical society, to be preserved in perpetuity for the benefit of science.”

This was adopted by unanimous vote of the stockholders.

The grooves thus preserved are probably the most remarkable in the world. They occur in the hard limestone of the vicinity, where the ice movement from the north-east encountered the projecting rock, and spent its main force upon it. As the ice pushed up and over the obstruction, a mingled mass of mud, sand, gravel, and boulders was shoved along beneath it. Under this force the boulders became ploughshares; the gravel and sand, rasps and files; and the frozen mud, a pumice-stone to furrow and score and polish the whole. Originally a large area of this glaciated surface was exposed to sight. But in the progress of work upon the extensive quarry, the larger part of it has been removed. What is left, however, is ample for an object lesson. The portion of the groove preserved is thirty-three feet across, and the depth of the cut in the rock is seventeen feet below the line extending from rim to rim. Originally there was probably here a small depression formed by pre-glacial water erosion, into which the ice crowded the material which became its graving tool; and so the rasping and polishing went on in increasing degree, until this enormous furrow is the result. The groove, however, is by no means simple, but presents a series of corrugations merging into each other by beautiful curves. When exposed for a considerable time it will resemble nothing else so much as a collection of prostrate Corinthian columns, lying side by side on a concave surface.

These grooves have long attracted the attention of the collectors of geological curiosities. Those persons in Cleveland who are interested to see specimens of this remarkable phenomenon can gratify their desire by noticing the collection of stones on the Public Square, just opposite the First Presbyterian Church. This was placed there by the Western Reserve Historical Society, and contains one of the first millstones used in the country. But beside it is a notable fragment of one of the glacial grooves from Kelley's Island. Mr. Younglove also has a still more remarkable specimen in front of his residence at 614 Euclid Avenue. Specimens of these grooves have also been procured for the Harvard College Museum, and a specially large and fine one was sent a year ago by Mr. Younglove to Oberlin, and adorns the college park in front of the library.

Col. Whittlesey paid much attention to the study of the grooves on Kelley's Island as they were in progress of being uncovered, and secured many fine specimens for the collection of the Historical Society, which can be seen in their rooms. The society also has a large number of original drawings of the grooves, executed by Col. Whittlesey, and accompanied by much unpublished descriptive matter. Neither has attention to those remarkable exhibitions of glacial action been confined to this country. In my recent work on the “Ice Age in North America,” I have taken pains to introduce several photographs from this place. In a recent issue the London *Athenæum* (March 28, 1891) fairly went into ecstasies over them, exclaiming, “How paltry appear the furrows ploughed by

ice on our glaciated rocks beside the monstrous groovings eroded on the Sandusky Islands in the western part of Lake Erie, and figured from photographs, at pp. 232–242 of this book.”

The direction of these grooves is a little south of west, corresponding to that of the axis of the lake. This is nearly at right angles to the course of the ice scratches on the summit of the water-shed south of this, between the lake and the Ohio River. The reason for this change of direction can readily be seen by a little attention to the physical geography. The high lands to the south of the lake rise about seven hundred feet above it. When the ice period was at its climax, and overran these high lands, it took its natural course at right angles to the terminal moraine, and flowed south-east, according to the direction indicated by the scratches on the summit. But when the supply of ice was not sufficient to overrun the high lands, the obstruction in front turned the course, and the resultant was a motion towards Toledo and the Maumee Valley, where, in the vicinity of Fort Wayne, an extensive terminal moraine was formed. The grooves on the islands near Sandusky were produced during that stage in the recession of the great ice-sheet.

The groove preserved is only a small portion of what still exists, but it would be too much to ask to have more given by the company. As it is, the public spirit shown by the directors, gathered from Boston to Duluth, has rarely been equalled by a similar corporation. Quarrying has already proceeded nearly all around this specimen, and soon the monument preserved will be a monument indeed, the groove being left to cap a pedestal about thirty feet high, and conspicuous from every side. About one half the surface will be cleared of *débris*, so as to show fifty feet of the length of the groove, while the other half will remain as it is, beneath its protective covering of pebbles, gravel, sand, and mud, which acted as the graving tools in the firm grasp of the ice. In this condition it is to be presented to the Western Reserve Historical Society of Cleveland, to remain for the admiration and instruction of all future generations. I trust the citizens of the vicinity will appreciate the noble gift enough to occasionally visit the place and receive the deep impressions it is so well calculated to make.

G. FREDERICK WRIGHT.

Kelley's Island, O., June 9.

Pacific Air over the Rocky Mountains.

IN last August I called attention in *Science* to the enormous mass of Pacific air which for three months had been passing eastward over the mountains: also to the fact that there had been but little precipitation during the summer until near the middle of August, when, for the first time, solar halos appeared, and were followed by violent electrical storms. From September to the middle of last January the atmospheric circulation was in general feeble, consisting largely of gentle winds from the north-west. Late in January the south-west currents began to flow again, at first feebly, but becoming more and more persistent and aggressive. A remarkable series of storms has followed, one storm following another at intervals of four days to three weeks. At first, after a rush of north wind had ended a storm, it would be one or two weeks before the south-west winds were re-established. But as time went on it took less and less time, until in April two of the worst of northers cleared off with the upper south-west wind still in possession of the field, rushing over the higher mountains as if nothing had happened, and in a few hours it became the surface wind on the plains. At present the plains near the mountains are wetter than for years.

I have had opportunity to observe these storms at a point 20 miles east of the mountains, 27 miles north-east of Colorado Springs, at 6,800 feet elevation, and near the top of the high ridge which extends east from the mountains known as the Divide between Arkansas and Platte waters. Seen from that place the most common development of the general storms was as follows. First, high cirrus streamers and films are seen coming from the quadrant south to west, more often from about south-west. For a day or more the surface winds continue variable, but finally the south-west wind descends to the surface. Then for several days the south-west wind continues, sometimes with a high velocity.